

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Claim 1. (currently amended) A method of facilitating placement of virtual appliances at desired positions on virtual teeth of an orthodontic patient using a workstation having a processing unit, memory having a three-dimensional virtual model of teeth of the patient, and an user interface including a display and software executable by said processing unit, comprising the steps of:

- (a) displaying three-dimensional virtual teeth model of a patient in a user selected dentition state of a patient;
- (b) selecting a virtual appliance placement reference for placing virtual appliances on said virtual teeth;
- (c) placing and displaying a virtual appliance at said appliance placement reference on a plurality of said virtual teeth in said user selected dentition state;
- (d) evaluating said virtual appliance placement for each of said plurality of virtual teeth is in a desired position; [[and]]
- (e) when one or more of said virtual appliances are not in said desired position, digitally simulating alternate placements for said virtual appliances and modifying said placement of said virtual appliances in order to achieve the desired placements[.]; and
- (f) displaying said virtual teeth in said virtual model in the form of a virtual two-dimensional (2D) panorax model with axial inclination for each tooth, enabling said

practitioner in modifying said placement of said virtual appliances, simulating its overall treatment effectiveness on said patient, and when a desired placement is achieved wrapping said virtual 2D panorax model in three-dimensional (3D) view.

Claim 2. (original) The method of claim 1, wherein said user selected dentition state of said patient comprises a malocclusion state.

Claim 3. (original) The method of claim 1, wherein said user selected dentition state of said patient comprises a target state.

Claim 4. (original) The method of claim 1, wherein said appliance placement reference comprises a bracket height reference and wherein step (b) comprises selecting said bracket height reference in at least one of the following ways: (i) for each of said virtual teeth, (ii) for groups of said virtual teeth, (iii) the same for all of said virtual teeth.

Claim 5. (original) The method of claim 1, wherein said appliance placement reference comprises an occlusal plane reference and wherein step (b) comprises selecting said occlusal plane reference, either in whole or in user selected segments.

Claim 6. (original) The method of claim 1, wherein said appliance placement reference comprises an arbitrary plane reference and wherein step (b) comprises selecting

said arbitrary plane reference, in whole or in user selected segments, in one of the following ways: (i) for lower arch, (ii) for upper arch, (iii) for lower arch and upper arch.

Claim 7. (original) The method of claim 1, wherein said virtual teeth comprise virtual teeth on (a) lower jaw, or (b) upper jaw, or (c) lower jaw and upper jaw.

Claim 8. (original) The method of claim 1, wherein said virtual appliances comprise virtual brackets prescribed by the practitioner or selected from a library of virtual brackets stored in said workstation's memory or a combination thereof.

Claim 9. (original) The method of claim 1, wherein said verifying step (d) includes examining said virtual appliance placement (a) locally for each said virtual tooth, (b) for selected groups of said virtual teeth, and (c) globally for all said virtual teeth.

Claim 10. (original) The method of claim 1, wherein said virtual appliances comprise virtual brackets prescribed by the practitioner or selected from a library of virtual brackets stored in said workstation's memory or a combination thereof and wherein said verifying step (d) includes detecting collision (a) between said virtual bracket and said virtual tooth on which said virtual bracket is placed on, and (b) between said one virtual bracket and said another virtual bracket.

Claim 11. (original) The method of claim 1, wherein said virtual appliances comprise virtual brackets prescribed by the practitioner or selected from a library of virtual brackets stored in said workstation's memory or a combination thereof and wherein said modifying said placement of said virtual appliances in step (e) further comprises enabling said user in replacing said one or more virtual brackets with those from said library of virtual brackets.

Claim 12. (original) The method of claim 1, further comprising the step of automatically measuring and marking said placement of said virtual appliances in relation to the surface of said virtual teeth in 2D and/or 3D.

Claim 13. (original) The method of claim 1, further comprising the step of enabling said user in measuring and marking said placement of said virtual appliances using the graph paper display in 2D and/or 3D.

Claim 14. (original) The method of claim 12, wherein said virtual appliances comprise virtual brackets prescribed by the practitioner or selected from a library of virtual brackets stored in said workstation's memory or a combination thereof and wherein said measuring and identifying the placement of said virtual appliances further comprises the step of measuring thickness of the gap between said virtual bracket and said virtual tooth surface for placing an adhesive pad.

Claim 15. (canceled)

Claim 16. (original) The method of claim 1, wherein said virtual appliances comprise virtual brackets prescribed by the practitioner or selected from a library of virtual brackets stored in said workstation's memory or a combination thereof and wherein said verifying step (d) includes enabling the practitioner in ascertaining that said virtual bracket is placed on the center of said virtual tooth.

Claim 17. (original) The method of claim 1, wherein said virtual appliances comprise virtual brackets prescribed by the practitioner or selected from a library of virtual brackets stored in said workstation's memory or a combination thereof and wherein said verifying step (d) further includes enabling the practitioner in viewing said virtual bracket placement using the clipping plane and in ascertaining that said virtual bracket is properly adapted to the surface of said virtual tooth; and said modifying the placement step (e) further comprises moving said virtual bracket to realize proper adaptation of said virtual bracket to the surface of said virtual tooth.

Claim 18. (original) The method of claim 1, wherein said virtual appliances comprise virtual brackets prescribed by the practitioner or selected from a library of virtual brackets stored in said workstation's memory or a combination thereof and wherein said verifying step (d) further comprises enabling the practitioner in viewing said virtual bracket placement and in ascertaining that said virtual bracket does not penetrate the

surface of said virtual tooth; and said modifying the placement in step (e) includes moving said virtual bracket to realize proper placement to remove any penetration of said virtual bracket from the surface of said virtual tooth.

Claim 19. (original) The method of claim 1, wherein said appliance placement reference comprises a bracket height reference and wherein step (b) comprises selecting said bracket height reference in one of the following ways: (i) for each of said virtual teeth, (ii) for groups of said virtual teeth, (iii) the same for all of said virtual teeth and wherein said verifying step (d) further includes enabling the practitioner in viewing said virtual bracket placement in relation to the occlusion plane and ascertaining that said virtual brackets are placed properly; and said modifying the placement in step (e) includes moving said virtual brackets to realize the desired relationship between said virtual brackets and said occlusal plane.

Claim 20. (original) The method of claim 19, wherein said occlusal plane is the upper occlusal plane.

Claim 21. (original) The method of claim 19, wherein said occlusal plane is the lower occlusal plane.

Claim 22. (original) The method of claim 19, wherein said occlusal plane is viewed in arbitrary sections selected by the practitioner.

Claim 23. (original) The method of claim 19, further comprising the step of changing the level of said occlusal plane and simulating its overall treatment effectiveness on said patient.

Claim 24. (original) The method of claim 19, further comprising the step of changing the angle of said occlusal plane and simulating its overall treatment effectiveness on said patient.

Claim 25. (original) The method of claim 19, further comprising the step of changing the curvature of said occlusal plane and simulating its overall treatment effectiveness on said patient.

Claim 26. (original) The method of claim 5, wherein said occlusion plane is lower occlusion plane.

Claim 27. (original) The method of claim 5, wherein said occlusion plane is upper occlusion plane.

Claim 28. (original) The method of claim 5, wherein said occlusion plane is lower occlusion plane and upper plane.

Claim 29. (original) The method of claim 5, wherein said occlusion plane is derived from cusp tips.

Claim 30. (original) The method of claim 5, wherein said occlusion plane is derived from marginal ridges.

Claim 31. (original) The method of claim 5, wherein said occlusion plane is derived arbitrarily.

Claim 32. (original) The method of claim 5, wherein said occlusion plane is derived in independent segments.

Claim 33. (original) The method of claim 1, wherein said virtual appliances comprise virtual brackets prescribed by the practitioner or selected from a library of virtual brackets stored in said workstation's memory or a combination thereof and wherein said verifying step (d) further comprises enabling said practitioner in checking said placement height, angulation, and torque of said virtual bracket and in step (e) simulating the overall treatment effectiveness of said virtual bracket placement on said patient.

Claim 34. (original) The method of claim 1, wherein said virtual appliances comprise virtual brackets prescribed by the practitioner or selected from a library of virtual brackets stored in said workstation's memory or a combination thereof and wherein said

verifying step (d) includes enabling said practitioner in ascertaining that the resulting marginal ridges are lined-up; and said modifying said placement step (e) includes moving said virtual bracket or said virtual brackets so that said marginal ridges are aligned.

Claim 35. (original) The method of claim 1, wherein said virtual appliances comprise virtual brackets prescribed by the practitioner or selected from a library of virtual brackets stored in said workstation's memory or a combination thereof and wherein said verifying step (d) comprises enabling said practitioner in ascertaining that the cusp tips are in the desired position; and said modifying the placement in step (e) includes the step of moving said virtual bracket or said virtual brackets in order to realize the desired positions of said cusp tips.

Claim 36. (original) The method of claim 1, wherein said virtual appliances comprise virtual brackets prescribed by the practitioner or selected from a library of virtual brackets stored in said workstation's memory or a combination thereof and wherein said modifying the placement in step (e) includes enabling the practitioner in placing said virtual bracket such that the reference virtual tooth is blocked from moving and simulating its overall treatment effectiveness on said patient.

Claim 37. (original) The method of claim 1, wherein said displaying said virtual appliances on said virtual teeth further comprises the step of enabling said practitioner in hiding said virtual teeth from the view.

Claim 38. (original) The method of claim 1, wherein said simulating in step (e) further comprises the step of simulating the effectiveness of the archwire configuration in conjunction with said bracket placement and making adjustments when necessary to realize said desired position of said patient's virtual teeth.

Claim 39. (original) The method of claim 38, wherein said archwire comprises a straight archwire.

Claim 40. (original) The method of claim 38, wherein said archwire comprises a custom archwire.

Claim 41. (original) The method of claim 38, wherein said archwire comprises a hybrid archwire.

Claim 42. (original) A method of placing virtual appliances at desired positions on virtual teeth of an orthodontic patient for planning mid-course treatment adjustment using a workstation having a processing unit, memory having a three-dimensional virtual model of teeth of the patient, and an user interface including a display and software executable by said processing unit, comprising the steps of:

displaying a three-dimensional virtual teeth model of a patient and virtual appliances in their current positions in an intermediate treatment state;

selecting a virtual appliance placement reference;

comparing said current virtual appliance placements with the placements recommended by said virtual appliance placement reference;

when said current position of said virtual appliance in said intermediate treatment state deviates from said appliance placement reference on said virtual tooth, repositioning and displaying said virtual appliance at said appliance placement reference;

verifying that said virtual appliance placement for each said virtual tooth is in desired position; [[and]]

when the virtual appliance is not in said desired position, digitally simulating alternate placements for said virtual appliances and modifying said placement of said virtual appliances in order to achieve the desired placements[[.]]; and

displaying said virtual teeth in said virtual model in the form of a virtual two-dimensional (2D) panorax model with axial inclination for each tooth, enabling said practitioner in modifying said placement of said virtual appliances, simulating its overall treatment effectiveness on said patient, and when a desired placement is achieved wrapping said virtual 2D panorax model in three-dimensional (3D) view.

Claim 43. (original) The method of claim 42, wherein said appliance placement reference comprises bracket height reference selected in at least one of the following ways: (i) for each of said virtual teeth, (ii) for groups of said virtual teeth, (iii) the same for all of said virtual teeth.

Claim 44. (original) The method of claim 42, wherein said appliance placement reference comprises an occlusal plane reference selected either in whole or in user selected segments, in one of the following ways: (i) for lower arch, (ii) for upper arch, (iii) for lower arch and upper arch.

Claim 45. (original) The method of claim 42, wherein said appliance placement reference comprises an arbitrary plane reference selected either in whole or in user selected segments, in one of the following ways: (i) for lower arch, (ii) for upper arch, (iii) for lower arch and upper arch.

Claim 46. (original) The method of claim 42, wherein said virtual appliances comprise virtual brackets prescribed by said practitioner or selected from a library of virtual brackets stored in said workstation's memory or a combination thereof.

Claim 47. (original) An apparatus for facilitating placement of virtual appliances at desired positions on virtual teeth of an orthodontic patient, comprising:

- a workstation having a processing unit and a display;
- a memory accessible by said workstation storing a virtual three-dimensional model of teeth and/or associated anatomical structures representing the dentition of a patient;
- software executable by said processing unit to access said model and display said model on said display; and

said software further including navigation tools enabling a user to interactively:

- (a) display said three-dimensional virtual teeth model of a patient in a user selected dentition state of a patient;
- (b) select a virtual appliance placement reference for placing virtual appliances on said virtual teeth;
- (c) place and display a virtual appliance at said appliance placement reference on a plurality of each of said virtual teeth in said user selected dentition state;
- (d) verify and evaluate that said virtual appliance placement for each of said plurality of virtual teeth is in desired position; and
- (e) when one or more of said virtual appliances are not suitably placed, digitally simulate alternate placements for said virtual appliances and modify said placement of said virtual appliances in order to achieve the desired placements[.];

wherein the navigation tools further comprise tools enabling the user in displaying the teeth in the virtual model in the form of a two-dimensional (2D) panorax showing axial inclination for each tooth, in modifying the placement of appliances, simulating its overall treatment effectiveness on the patient, and when a desired placement is achieved, in wrapping the virtual 2D model in three-dimensional (3D) view.

Claim 48. (original) The apparatus of claim 47, wherein said user selected dentition state of said patient comprises malocclusion state.

Claim 49. (original) The apparatus of claim 47, wherein said user selected dentition state of said patient comprises target state.

Claim 50. (original) The apparatus of claim 47, wherein said appliance placement reference comprises bracket height reference selected in one of the following ways: (i) for each of said virtual teeth, (ii) for groups of said virtual teeth, (iii) the same for all of said virtual teeth.

Claim 51. (original) The apparatus of claim 47, wherein said appliance placement reference comprises arbitrary plane reference selected, either in whole or in user selected segments, in one of the following ways: (i) for lower arch, (ii) for upper arch, (iii) for lower arch and upper arch.

Claim 52. (original) The apparatus of claim 51, wherein said arbitrary plane reference comprises occlusal plane reference.

Claim 53. (original) The apparatus of claim 47, wherein said navigation tools further enable the user to view and manipulate marginal ridges.

Claim 54. (original) The apparatus of claim 47, wherein said navigation tools further enable the user to view and manipulate cusp tips.

Claim 55. (original) The apparatus of claim 47, wherein said navigation tools further enable the user to view and select reference tooth or teeth.

Claim 56. (original) The apparatus of claim 47, wherein said appliances are brackets.

Claim 57. (original) The apparatus of claim 56, wherein said brackets are selected from a library of brackets stored in said workstations' memory.

Claim 58. (original) The apparatus of claim 56, wherein said brackets are prescribed by the practitioner.

Claim 59. (original) The apparatus of claim 47, wherein said appliances are brackets and wherein said navigation tools further enable the user to detect collision (a) between the bracket and the tooth, (b) between the bracket on one tooth and the bracket on the neighboring tooth on the same arch, and (c) between the bracket on one tooth and the bracket on the neighboring tooth on the opposite arch; and to modify the placement by moving the bracket or the brackets to eliminate collision.

Claim 60. (original) The apparatus of claim 47, wherein said appliances are brackets and wherein said navigation tools further enable the user to select a different type of bracket from the bracket library and to replace the current bracket on the particular tooth with the selected bracket and to simulate its overall treatment effectiveness on the patient.

Claim 61. (original) The apparatus of claim 47, wherein the navigation tools further comprise tools enabling the user in automatically measuring and to identifying the placement of the appliances in relation to the tooth surface.

Claim 62. (original) The apparatus of claim 47, wherein the navigation tools further comprise tools enabling the practitioner in measuring and identifying the placement of the appliances using the graph paper display.

Claim 63. (original) The apparatus of claim 62, wherein the measurements are enabled in all three dimensions of space.

Claim 64. (original) The apparatus of claim 62, wherein said appliances are brackets and wherein the navigation tools further comprise tools enabling the user in measuring thickness of the gap between the bracket and the tooth surface for placing adhesive pad.

Claim 65. (canceled)

Claim 66. (original) The apparatus of claim 47, wherein said appliances are brackets and wherein the navigation tools further comprise tools enabling the user in ascertaining that the bracket is placed on the center of the tooth.

Claim 67. (original) The apparatus of claim 47, wherein said appliances are brackets and wherein the navigation tools further comprise tools enabling the user in viewing the bracket placement using the clipping plane and in ascertaining that the bracket is properly adapted to the surface of the tooth; and in moving the bracket to realize proper adaptation of the bracket to the tooth surface.

Claim 68. (original) The apparatus of claim 47, wherein said appliances are brackets and wherein the navigation tools further comprise tools enabling the user in viewing the bracket placement and in ascertaining that the bracket does not penetrate the surface of the tooth; and in moving the bracket to realize proper placement to remove any penetration of the bracket from the tooth surface.

Claim 69. (original) The apparatus of claim 47, wherein said appliances are brackets and wherein the navigation tools further comprise tools enabling the user in viewing the bracket placement in relation to the occlusion plane and in ascertaining that the brackets are placed properly; and in moving the brackets to realize the desired relationship between the brackets and the occlusal plane.

Claim 70. (original) The apparatus of claim 47, wherein said appliances are brackets and wherein the navigation tools further comprise tools enabling the user in checking the placement height, angulation, and torque of the bracket and in simulating its overall treatment effectiveness on the patient.

Claim 71. (original) The apparatus of claim 47, wherein said appliances are brackets and wherein the navigation tools further comprise tools enabling the user in ascertaining that the resulting marginal ridges are lined-up; and in moving the bracket or the brackets for aligning the marginal ridges.

Claim 72. (original) The apparatus of claim 47, wherein said appliances are brackets and wherein the navigation tools further comprise tools enabling the user in ascertaining that the cusp tips are in the desired position; and in moving the bracket or the brackets for realizing the desired cusp tips positions.

Claim 73. (original) The apparatus of claim 47, wherein said appliances are brackets and wherein the navigation tools further comprise tools enabling the user in placing the bracket such that the reference tooth is blocked from displacement and in simulating its overall treatment effectiveness on the patient.

Claim 74. (original) The apparatus of claim 47, wherein the navigation tools further comprise tools enabling the user in displaying bounding boxes around the teeth for aiding in assessing teeth movement.

Claim 75. (original) The apparatus of claim 47, wherein the navigation tools further comprise special visualization tools enabling the user in selecting, visualizing and modifying said patient's axial inclinations of crowns and roots of said patient's dentition in 2D and 3D.